Instance segmentation algorithm of cells (yeast, mammalian cells, etc)

Synthetic image generator

Image 2048 x 2048 pixel

Yeast cells

Input:

1. Property of the image: width, height
2. Features of the cells:
   1. Number of cells
   2. Fluorescence level,
   3. Size,
   4. Shape
   5. Location
   6. Etc
3. Additional properties that might affect how the fluorescence image would look like. Be reasonable and make it as realistic as you can (hint: consider variations of cells and noise from camera)

Output:

1. The generated fluorescence images of yeasts in uint16.
2. The corresponding labeled image in unit8 (background is 0, and cells are labeled in increment numbers, uint8 is assuming the maximum supported cell count per image is 255)

Yeast cell background:

Yeasts are eukaryotic, single-celled microorganisms. They reproduce by mitosis, or budding (asymmetric division). They vary in size, but typically 3-4 um in diameter. From the picture provided, the ones we work with likely vary from 2-6 in ellipse shape.

Thus, individual cells could be modeled as an ellipse with a and b vary from 2-8 um, and a rotation from the axis.

Because yeasts are eukaryotic, with nucleus. Most expressed fluorescent proteins are not in nucleus. Thus, a more realistic image would have a much lighter nucleus region. The nucleus can be modeled as circular structure.

For simplicity, we can position a circle as nucleus at the ellipse center with 0.9 of the minor axis length, with fluorescent intensity as 0.1 of the indicated fluorescent intensity.

Noise: camera noise, background noise.

Photon noise: from the emission (and detection) of the light itself. This follows a Poisson distribution, for which the standard deviation changes with the local image brightness.

Read noise: arising from inaccuracies in quantifying numbers of detected photons. This follows a Gaussian distributions, for which the standard deviation stays the same throughout the image.

Other noise.

UI design

1. Parameters panel
   1. Noise panel

Preview button

Generate button